Photo by Roger Ruess

Photo by Mark Chapin

Current (top) and potential future (left) view of the Tanana River floodplain, Interior Alaska.

Keynote Address

Alaska Parks in a Warming Climate: Conserving a Changing Future

by F. Stuart Chapin, III

Alaska's national parks can make a unique contribution in defining the future role of the National Park Service and the way in which the United States and other countries respond to global environmental and ecological changes. The mission of the NPS is "to conserve the scenery, and the natural and historic objects and wildlife therein, and to provide for the enjoyment of the same, so as to leave them unimpaired for the enjoyment of future generations." How is it possible to conserve these things if the climate that determines their basic properties is changing in a directional fashion over time? What should be the roles of national parks in a rapidly changing world? These are the challenges I would like to address. I suggest that we must accept that changes will continue to occur and that it is important to plan for change. In so doing, the parks could serve as an important role model for society in learning how to live with change. This is very different from viewing parks as "museums of nature" that are protected from the changes that are occurring elsewhere in the world. Attempting to preserve museums of nature would be a dangerous approach in a directionally changing world because it would place these parks far from their natural balance with climatic and social driving forces that govern their fundamental properties.

Air temperature in Alaska is increasing as rapidly as any place on Earth *(Figure 1)*. The rate of warming in Alaska has increased *(Chapin et al. 2005)* and is projected to increase even more rapidly in the future *(ACIA 2005)*. Temperature is increasing most rapidly in winter, so we should expect more frequent winter thaw events and winter rains that produce ice layers that influence animal access to their winter food. The mountain glaciers of the world are shrinking, with the largest decreases occurring in Alaska *(Figure 2),* a trend that will also likely continue.

As climate warms, trees expand into alpine areas, and tundra becomes more shrubby *(Sturm et al. 2001, Lloyd et al. 2003, Wilmking et al. 2004)*. These ecological changes have many important consequences. They alter the vistas that bring people to Alaska parks. They increase the energy absorbed by vegetation and its transfer to the atmosphere, contributing to the high-latitude amplification of climate warming *(Chapin et al. 2005)*. Increases in shrubs shade out lichens, an important winter forage for caribou *(Cornelissen et al. 2001)*. Not all of these habitat changes are unfavorable for wildlife. Increases in willow biomass from warming and from increased fire activity improve habitat for moose. Although the precise nature of these changes and the rates at which they will occur are uncertain, it is quite clear that the ecology and landscape character of Alaska national parks, which the Park Service is tasked with conserving, will continue to change, probably more rapidly than they have in the past.

Park visitation, which can also affect parks, has also been increasing for several reasons. Human population is increasing in Alaska, nationally, and globally. In addition, human transformation of the earth's surface shrinks the areal extent of remaining wilderness. Together these trends tend to increase pressure on the remaining wilderness. As people have more leisure time, there will likely be increased interest in experiencing places like the national parks of Alaska. It therefore seems inevitable that park visitation will continue to increase, causing both direct visitor impacts on parks and pressures for development in the surrounding regions.

How can Alaska parks address these issues, given that the effects are largely caused by human behavior that is dispersed globally and whose impacts, in terms of climate warming, are amplified at high latitudes? One potential role for Alaska's national parks is to demonstrate clearly the consequences of warming and to tell this story very convincingly to park visitors and to the public at large. Alaska parks are some of the best examples of ecosystems that are undergoing dramatic change. Consequently, parks could play a very important role in documenting and in educating their visitors about change. This redefinition of the educational role of Alaska's national parks might identify the major causes of change and the processes that underlie the dynamics of change. An important goal of such an

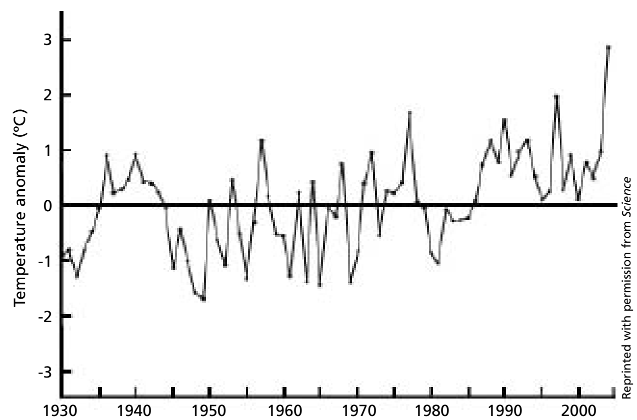

Figure 1. Change in average air temperature of Alaska *(Chapin et al. 2005).*

education program might be to demonstrate how human actions throughout the world are affecting the Earth System so strongly as to have environmental and ecological consequences even in parks and monuments that are remote from direct population pressures and protected from most types of direct human impacts.

Developing a broader perspective on change is important but will not be sufficient. If warming continues, parks must alter their approach to managing wilderness. This may require fundamentally redefining the nature of the resources that the Park Service is tasked to protect for the future, i.e., the resources that will remain for future generations to enjoy. If past trends continue, there will inevitably be changes in species composition as a result of new arrivals and some disappearances. Perhaps the role of the NPS is not to attempt to prevent these changes from occurring, but to preserve biodiversity and its functional consequences in a broad sense. Perhaps it is more important to provide the opportunity for landscape processes to adjust to externally driven change (e.g., more wildfire) rather than to maintain a landscape that is increasingly out of equilibrium with its climatic determinants.

Managing for diversity and ecological dynamics rather than for the current habitat structure and population sizes will require the development of new kinds of science and new perspectives on management. For example, it will require an understanding of the properties of migration corridors by which species arrive and those aspects of population dynamics that influence dispersal. What types of corridors will maintain functional diversity by allowing functionally similar species to arrive as some current species decline in abundance? How can corridors be designed or barriers established that will reduce the likelihood of spread of functionally different species (e.g., weeds or nitrogen-fixing plants) into parks? Can elevation gradients be viewed as opportunities for current species to migrate successfully over short distances to maintain their current relationship to climate, thereby reducing their likelihood of loss? Is it feasible to define and manage for aesthetic values, rather than attempting to preserve static landscapes? As species composition and ecosystem boundaries (e.g., treeline) continue to shift, it may be more appropriate for the Park Service to preserve an opportunity for people to maintain their sense of identity with nature and culture rather than attempt to preserve a particular landscape structure. This requires a focus on sustaining landscape dynamics rather than current vistas—managing to foster flexibility rather than to prevent changes from occurring.

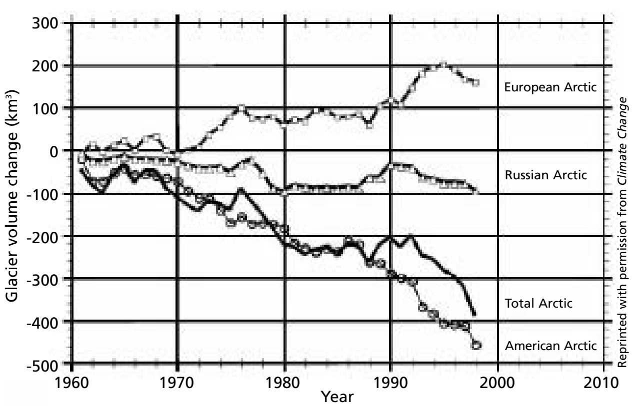

Figure. 2. Trends in glacial volume for different arctic regions *(Hinzman et al. 2005).*

The thawing of permafrost and flooding of glacial rivers are other disturbances that are likely to increase. The combined impact of all climate-related disturbances is likely to create quite a different future landscape than we see today.

Managing of migratory corridors to facilitate biological adjustment to climate change will require innovative thinking. Most Alaska parks have dramatic topographic climatic gradients that occur over short distances that could allow climatically sensitive species to maintain their current relationship to climate. Species migration is nothing new. It has been a common response to past climatic changes. However, in the past, species have typically had hundreds or thousands of years to adjust to a magnitude of climate change that is now occurring in a few decades. An important role for current biological monitoring programs is to document species shifts that may already be occurring. Documentation of factors that facilitate species migration could provide a basis for landscape management that creates corridors for elevational migration of climatically sensitive threatened species. This is one example of ways in which understanding the dynamics of change can contribute to broad goals of conserving biodiversity and other natural values for future generations.

Managing landscape-scale disturbances such as pest outbreaks and wildfire has been, and will continue to be, an important management issue in Alaska national parks. Many disturbances will become more frequent as climate continues to warm. For example, in the Kenai Peninsula, warming allowed the spruce bark beetle to shift from a 2-year to a 1-year life cycle, causing a threshold change in biology of this insect species and its interaction with its host tree *(Berg et al. 2006)*. This resulted in one of the largest naturally occurring insect outbreaks in North America.

Fire regime is also changing. Climate warming has caused an increase not only in the average temperature but also in the number of extremely warm days, which increases the extent of wildfire and other temperature-related disturbances. The area burned in western North America has doubled in the last 40 years *(Kasischke and Turetsky 2006)*. The last 15 years account for half of the large fire years in Alaska's 50-year fire record as a result of regional warming and drying, a trend that is likely to continue in the future. These changes in fire regime have important implications for migration corridors. For example, lichens require about 80-100 years to recover after fire, so, as fire risk increases in a warming climate, policies to suppress wildfires to preserve critical corridors for caribou migration warrant consideration. Alternatively, the migration of other species, e.g., moose, may be favored by increased fire frequency.

The thawing of permafrost and flooding of glacial rivers are other disturbances that are likely to increase. The combined impact of all climate-related disturbances is likely to create quite a different future landscape than we see today. These future landscapes are not necessarily less functional or "worse" than the landscapes of today, but they will be different. The Park Service can play an important role in understanding and explaining these landscape changes.

Given the increasing frequency of many of Alaska's naturally occurring types of disturbance, the management of disturbance will be an important tool for managing landscapes for the long term at large spatial scales. For example, fire managers have been quite successful in suppressing wildfire in populated portions of the state relative to more remote regions, where most fires are allowed to burn *(Figure 3)*. This reduction in area burned has occurred despite an increase in human ignitions and a lengthening of the time when ignitions occur. Although wildfire management has generally focused on reducing risk to life and property in densely populated areas, it can also be used as a tool to manage landscapes for conservation goals. Fire suppression can protect critical caribou migration corridors in a fire-prone landscape. On the other hand, allowing wildfire to burn can create buffers that reduce the likelihood of future fires. The shrubby and deciduous vegetation that dominates after fire is less flammable than late-successional spruce forests *(Figure 4)*. These are only two examples of ways in which the management of natural processes can be used to design landscapes that conserve resource values for future generations.

Given the importance of managing national parks for the long term over large spatial scales, it is useful to think about the interaction between parks and their surroundings. Some of the ways that parks interact with the surrounding matrix may be undesirable as a result of development and pollution occurring near parks. This concentration of human activity also increases human ignitions and produces more fires that spread into parks than might be expected based on climate and vegetation. Similarly, hunting of migratory wildlife in the matrix surrounding parks can influence population dynamics within parks. Park managers are generally well aware of these issues and manage activities in parks accordingly. As climate change and species migration become increasingly important to parks, collaborative arrangements with communities and the managers of adjacent lands will have increasing impact on the dynamics that occur within park boundaries. The continually evolving land ownership and management rules in Alaska may provide opportunities to plan creatively to influence changes that are likely to occur in the matrix around parks. In addition, development pressures around most Alaska parks are still relatively modest, compared to what can be expected in a few decades. The magnificent landscapes that characterize Alaska parks attract both people that recognize potentials for economic development and others who are more interested in sustaining the current wilderness character of the landscape. Partnerships to plan and manage the matrix that surrounds Alaska parks are probably at least as important as the management of parks themselves.

Alaska national parks have inadvertently been thrust into a leadership role in redefining Wilderness in a way that includes people *(Chapin et al. 2004)*. The maps of Alaska

Figure 3. Photograph of wildfire in Alaska black spruce forest.

ecosystems and cultural groups are virtually identical because ecology shapes culture, and indigenous peoples have managed the lands in which they live. Because of these tight linkages, ecology and cultures cannot really be separated. Consequently, if parks are dedicated to conserving landscapes, this also provides opportunities to conserve the cultural roots of the people that inhabit these lands. Many (but not all) Alaska parks are tasked by legislation to foster these social-ecological linkages by allowing local residents continued access to traditional subsistence hunting and fishing opportunities. This is quite different than wilderness as defined by the Wilderness Act: "a place where man is a visitor and does not remain". This legislative definition is based, in part, on impressions of early settlers in the western U.S. who observed an unoccupied land that had been depopulated by disease prior to or coincident with the arrival of white settlers.

Managing an inhabited wilderness is not an easy task, because the technology of subsistence use is constantly changing, just as it always has, most recently as a result of cultural and technological adjustments to western influences. Athabascan people in Interior Alaska, for example, used to live in small mobile family bands that moved regularly in response to seasonal and successional changes in availability of subsistence resources *(Natcher et al. 2007)*. When a large fire occurred, these bands simply moved to new areas where subsistence opportunities were better. Now, people that live a subsistence lifestyle are locked in place by airports, schools, churches, health centers, etc. *(Huntington et al. 2006, Natcher et al. 2007)*. To some extent, this reduction in mobility can be compensated by modern transport (e.g., snow machines and motorboats). Innovation and adaptation have always been important to the success of Alaska indigenous cultures, but many of the recent technological innovations (e.g., snow machines) are also used for recreation in ways that many people view as inconsistent with wilderness. There is no easy answer to the resulting controversies. However, regulations regarding use of motorized transport in parks have deep cultural implications that warrant consideration.

Figure 4. Patch of deciduous forest that did not burn despite fires that converged on it from all sides during the 2004 Boundary fire near Fairbanks.

Management of disturbance is particularly challenging in the context of social-ecological change. Subsistence resources show relatively predictable rates of recovery after wildfire. Blueberries recover quickly, marten and moose peak about 15-30 years after wildfire, and caribou require 80-100 years to recover. A typical response of wildlife managers to these observations is to say "We have to maintain fire on the landscape in order to maintain this diversity of wildlife." On the other hand, a subsistence hunter who is locked in place by infrastructure is likely to say "It will be a generation before moose return to this landscape, so how can I teach my children about their cultural ties to the land if fires are allowed to burn?" Clearly the use of disturbance for landscape management has important cultural connotations and requires active engagement of people who live on and use the land. Constructive solutions to these multiple concerns may involve careful attention to the configuration of fire on the landscape relative to the locations of human harvest.

Alaska parks are also important to non-residents, even to those people who may never visit them. As global wilderness continues to shrink, non-use or non-consumptive use of wilderness may become increasingly valued. Currently about half the world's population lives in cities, a proportion that will likely increase *(MEA 2005)*. An important educational opportunity and challenge is to convey the importance of wilderness to people everywhere on Earth and to help reconnect these people to the land.

Change is not going to be simple. The changes described above will interact in complex and often unpredictable ways. This provides the Park Service with both an obligation and an opportunity to be at the forefront of learning about the complexities of adjusting to change. The changes faced by Alaska national parks are a microcosm of trends that are occurring globally. Being the steward of a constantly changing treasure provides the Park Service many educational and management opportunities to play a constructive role in reducing detrimental changes and finding ways to foster constructive change.

Given that things are changing so quickly, it is an opportunity for the Park Service to rethink and redefine its goals. Conservation of biodiversity requires a very different strategy now than in the past. Conserving biodiversity and human connections to the land will require a long-term perspective. Although we cannot describe in detail the specific landscape that we seek to conserve, we know a lot about the dynamics of change and their implications for effective management. It involves managing the matrix, for the long term, for corridors that will allow species to move along climatic gradients as climate changes. The Park Service has several important roles to play in educating the public about change, in developing partnerships to foster cultural adjustments, and in developing new mental models for society globally to live with change.

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